View metadata, citation and similar papers at core.ac.uk
brought to you by CORE
provided by IUPUIScholarWorks

AFM-Based Nanofabrication: Modeling, Simulation, and Experimental Verification

Rapeepan Promyoo[1], Hazim El-Mounayri[1], Varun Kumar Karingula[1], Kody Varahramyan[2]
[1]Department of Mechanical Engineering, Purdue School of Engineering and Technology, IUPUI;
[2]Department of Electrical and Computer Engineering, Purdue School of Engineering and Technology, IUPUI

Recent developments in science and engineering have advanced the fabrication techniques for micro/ nanodevices. Among them, atomic force microscope (AFM) has already been used for nanomachining and fabrication of micro/nanodevices. In this paper, a computational model for AFM-based nano-fabrication processes is being developed. Molecular Dynamics (MD) technique is used to model and simulate mechanical indentation and scratching at the nanoscale. The effects of AFM-tip radius and crystal orientation are investigated. The simulation is also used to study the effect of the AFM tip speed on the indentation force at the interface between the tip and the substrate/workpiece. The material deformation and indentation geometry are extracted from the final locations of atoms, which are displaced by the rigid indenter. Material properties including modulus of elasticity and hardness are estimated. It is found that properties vary significantly at the nanoscale. AFM is used to conduct actual nanoindentation and scratching, to validate the MD simulation. Qualitative agreement is found. Finally, AFM-based fabrication of nanochannels/nanofluidic devices is conducted using different applied forces, scratching length, and feed rate.

Advisor: Hazim El-Mounayri, Department of Mechanical Engineering, Purdue School of Engineering and Technology, IUPUI